Japanese Altimetry Mission, COMPIRA

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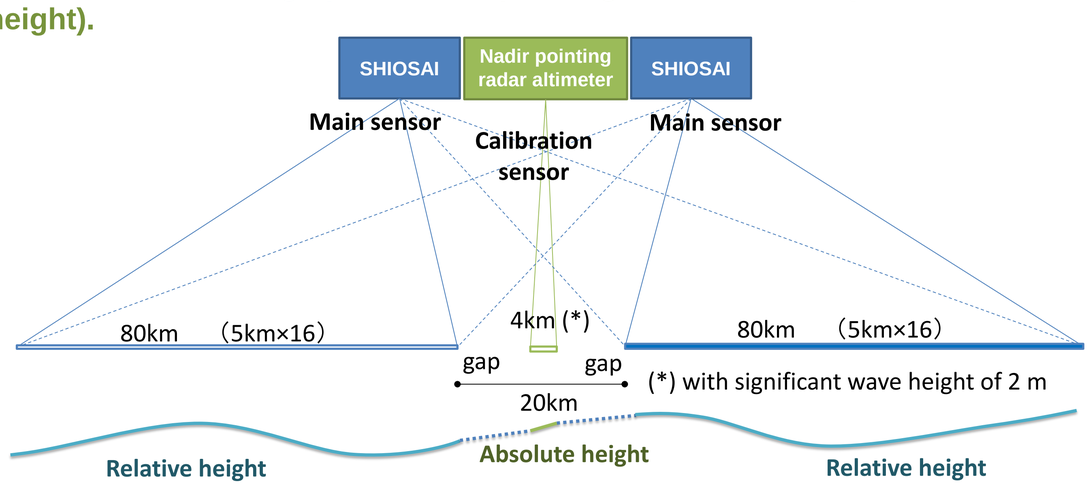
Introduction

Japan Aerospace Exploration Agency (JAXA) has proposed a new altimetry mission, COMPIRA (Coastal and Ocean Measurement mission with Precise and Innovative Radar Altimeter) [1]. There are three main purposes of the COMPIRA mission; ocean currents forecast for various human activities over the ocean including ship navigation, fishery for estimating fishing places, and scientific outcomes including ocean submesoscale phenomena, sea-level rise phenomena, and improvement of Tsunami forecast model. To obtain sea surface height data over the coastal region, wide-swath measurement is effective. COMPIRA will carry a wide-swath altimeter with two synthetic aperture radar antennas, named SHIOSAI (SAR Height Imaging Oceanic Sensor with Advanced Interferometry), having 80 km swath in both left and right sides. To meet the accuracy requirement of sea surface (~7.5 cm, with spatial resolution of 5 km), POD (Precise Orbit Determination) is quite important. In the poster, we will present overview of the COMPIRA mission.

Measurement

Measurement of absolute sea surface height with wide-swath and high presition will be realized by combining SHIOSAI (Interferometric SAR sensor; to obtain relative height) and nadir pointing radar altimeter (to obtain absolute height).



Products

COMPIRA standard (Level-2) products consist of the following three types depending on latency:

1) **Near-real-time products**
2) **General products**
3) **High-precision products**

Products	Latency	Accuracy
Near-real-time	6-12 hours	5.4 cm (relative) 12.2 cm (absolute)
General	3 days	7.5 cm (absolute)
High-precision	60 days	6.9 cm (absolute)

Corrected Sea Level Anomaly (SLA)/ Absolute Dynamic Topography (ADT), and SLA/ ADT/ Geostrophic Current maps are produced from Geophysical Data Records (GDR)

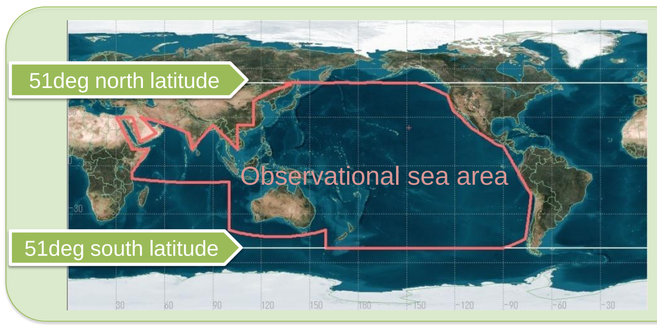
Requirements

COMPIRA Requirements

Item		Specification		
Spatial resolution		5 km		
Time to offer product		6–12 h	3 days	60 days
Accuracy (*)	relative	5.4 cm	5.4 cm	5.3 cm
	absolute	12.2 cm	7.5 cm	6.9 cm
Frequency		Twice per 10 days		
Observational area		Sea around Japan, from the Persian Gulf to the west coast of the U.S.		
Distance to coastal line		10 km		
Rain error		1%		
Coverage		98% @ 35°N latitude		
Product		Sea surface height, sea level anomaly, absolute sea surface height, Geophysical Data Record		
Tide		Observation for computable harmonic constant of main tide		

SHIOSAI Sensor Requirements

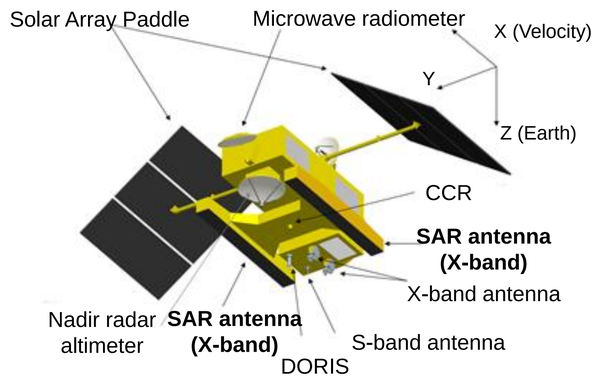
Item	Specification
Sensor system	Interferometry SAR （2 antennas along the ground range ）
Swath	80km×2 （Both side observation）
Frequency	9.6GHz band
Spatial resolution	5km × 5km
Sea height error (sensor-induced)	4.2cm (*) (*) Average in swath

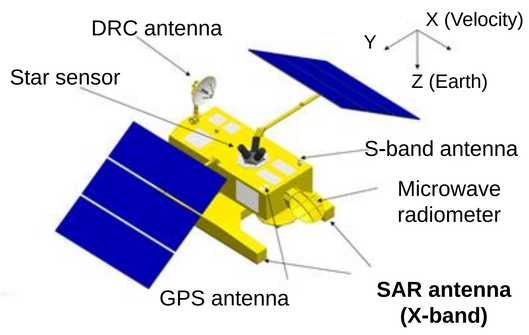


COMPIRA Observational Sea Area and Orbit Parameters

- Recurrent Period: 10days
  - Altitude: 937.49 km
  - Inclination: 51.2 deg

Satellite Configuration





X-band SAR Antennas will be mounted on the satellite bus structure directly.

Mission Payload	Reason to use
SHIOSAI (X-band SAR：9.6 GHz)	Measurement of SSH with wide swath
Nadir-radar altimeter (dual frequency：Ku + C-band)	Measurement of absolute SSH Calibration with past and currently-operated satellites
Microwave radiometer (three frequency)	Correction of range delay due to water vapor
GPS receiver	POD (Precise orbit determination)
LRA (Laser Retroreflector Array)	
(DORIS)	

POD Requirements

POD (Precise orbit determination) will be conducted using GPS-based POD software developed by JAXA. In addition to GPS measurements, Satellite Laser Ranging (SLR) observations are used to calibrate biases of GPS-determined orbits and to obtain combined precise orbits from SLR/GPS measurements with the cooperation of ILRS (International Laser Ranging Service) stations.

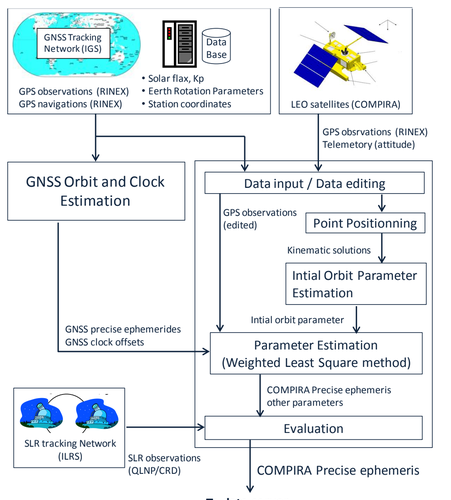
Requirements of orbit determination

Products	Latency	Orbit Accuracy(radial)	Measurements
Near-real-time	6-12 hours	10 cm (RMS)*	GPS
General	Nominal:1 day with orbit control:3 days	4 cm (RMS)	GPS (+SLR)
High-precision	60 days	3 cm (RMS)	GPS + SLR

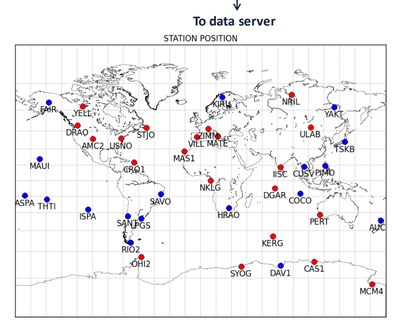
* Orbit accuracy will be measured with regard to the High-precision ephemeris.

POD Software and Its Evaluation

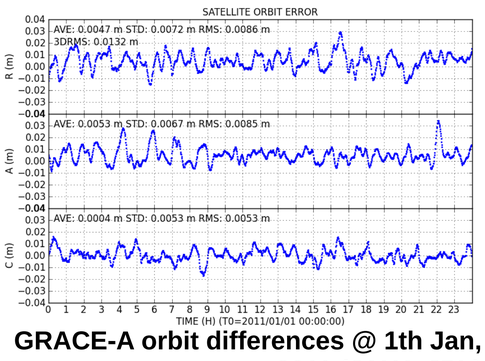
JAXA developed the GNSS precise orbit and clock estimation software, “MADOCA” in 2011 and 2012, which can estimate GNSS orbits with accuracy of a few centimeters [2]. In order to evaluate above requirements of COMPIRA orbit determination, JAXA has developed a new POD software by expanding the capabilities of MADOCA to cover both GNSS and LEO satellites making use of the measurement and dynamic model, as well as the parameter estimation algorithm that were already implemented to MADOCA.



In order to evaluate the POD software for COMPIRA, orbit determination tests were conducted using GPS observations received in GRACE-A satellite on 1 Jan 2011 (NASA/JPL) [3]. The GNSS precise ephemeris and clock offsets were fixed to the IGS final orbit and IGS high-rate clock products [4], respectively. Moreover, the ground GPS observations in 40 IGS (International GNSS Service) stations shown in the figure on the right were processed with integer carrier-phase ambiguity fixing procedure.
The figure on the right shows the GRACE-A orbit error with regards to the precise ephemeris derived form JPL level-1B products[3]. This result indicates that the POD software developed by JAXA will have a good performance to meet the requirements of COMPIRA precise orbit products.



IGS Tracking Network (40 stations)



GRACE-A orbit differences @ 1th Jan, 2011 (JAXA-JPL)

References

[1] A. Uematsu, R. Nakamura, Y. Nakajima, Y. Yajima, and the JAXA COMPIRA team: X-band interferometric SAR sensor for the Japanese altimetry mission, COMPIRA, in Proc. IGARSS, Melbourne, July 2013.
[2] M. Miyoshi, S. Kogure, S. Nakamura, K. Kawate, H. Soga, Y. Hirahara, A. Yasuda and T. Takasu: he orbit and clock estimation result of GPS, GLONASS and QZSS by MADOCA, ISSFD, 2012.
[3] K. Case, G. Kruizinga and S. Wu: GRACE level 1B data product user handbook, JPL Publication D-22027, Jet Propulsion Laboratory, Pasadena, 2002.
[4] J. Kouba: A guide to using international gnss service (igs) products, 2009.